

CLAIMS:

1. A method of making a spectral filter comprising:
providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,
providing etching start points at a first surface of said semiconductor wafer,
and
etching the substrate wafer beginning at said start points to produce a structured layer having pores with controlled depths defined at least partially therethrough, said pores having coherently modulated cross-sections at least over the part of said depth.
2. The method of **claim 1**, wherein said etching start points compose a regularly-arranged array of depressions on the first surface of substrate wafer.
3. The method of **claim 1**, wherein said etching start points are located by producing a photoresist mask on the first surface of the substrate wafer and by a subsequent etching of the first surface through said photoresist mask.
4. The method of **claim 3**, wherein said etching is chosen from the group consisting of chemical etching, reactive ion etching, and ion milling.
5. The method of **claim 4**, wherein said chemical etching is chosen from the group consisting of alkaline etching and acidic etching.
6. The method of **claim 1**, wherein said surface topology is produced by disposing a layer of material with different chemical properties than those of wafer material on the first surface of substrate wafer, by producing a photoresist mask on the surface of said layer, by etching away the said chemically different material inside the photoresist mask openings and by etching the wafer surface through the thus-formed openings in said disposed chemically different material.
7. The method of **claim 6**, wherein said chemically different layer is silicon dioxide and is disposed by a step chosen from the group consisting of: thermal oxidation of the surface of wafer in the oxygen-contained atmosphere, chemical vapor deposition, wet chemical oxidation and physical vapor deposition.

8. The method of **claim 6**, wherein the said layer is a silicon nitride layer disposed by a step chosen from the group consisting of chemical vapor deposition and physical vapor deposition.

9. The method of **claim 6**, wherein said chemically different layer is removed from the first surface of the wafer after forming said surface topology in the wafer.

10. The method of **claim 1** wherein said semiconductor substrate wafer is asilicon wafer.

11. The method of **claim 10**, wherein said silicon wafer is a (100)-oriented wafer.

12. The method of **claim 10**, wherein said electrochemical etching occurs in a fluoride-containing, acidic electrolyte.

13. The method of **claim 12**, wherein said electrolyte contains hydrofluoric acid in a range of 1% to 50% by volume.

14. The method of **claim 12**, wherein said electrolyte additionally contains an oxidizing agent.

15. The method of **claim 12**, wherein said electrolyte additionally contains a hydrogen reducing agent selected from the group of chemicals consisting of mono functional alkyl alcohols, tri functional alkyl alcohols, and tri functional alkyl alcohols.

16. The method of **claim 12**, wherein said electrolyte additionally contains a viscosity-modifying agent.

17. The method of **claim 12**, wherein said electrolyte additionally contains a conductivity-modifying agent.

18. The method of **claim 12**, wherein said electrolyte additionally contains a wetting agent.

19. The method of **claim 12**, wherein said silicon wafer is an n-type doped wafer and said etching is electrochemical etching and includes connecting the substrate as an electrode, contacting the first surface of the substrate with an electrolyte, setting a voltage between said electrodes, illuminating a second surface of the substrate wafer that lies opposite the first surface to generate charge carriers

producing current between said electrodes and continuing etching to form said pores extending to a desired depth substantially perpendicular to said first surface.

20. The method of **claim 19**, wherein at least one electrochemical etching parameter selected from the group consisting of illumination intensity, electrolyte temperature and/or applied voltage is changing in a predetermined fashion with time during the electrochemical etching process.

21. The method of **claim 12**, wherein said silicon wafer is a p-type doped wafer and said etching is electrochemical etching and includes connecting the substrate as an electrode, contacting the first surface of the substrate with an electrolyte, setting a current between said electrodes, and continuing etching to form said pores extending to a desired depth substantially perpendicular to said first surface.

22. The method of **claim 21**, wherein the electrolyte additionally contains at least one organic additive.

23. The method of **claim 22**, wherein the said at least one organic additive is selected from the group consisted of acetonitrile, dimethylformamide, dimethylsulfoxide, diethyleneglycol, formamide, hexamethylphosphoric triamide, isopropanol, triethanolamine, 2-methoxyethyl ether, triethylphosphite, and triethyleneglycol dimethyl ether.

24. The method of **claim 21**, wherein at least one electrochemical etching parameter selected from the group consisting of electrical current density, electrolyte temperature and/or applied voltage is changing in a predetermined fashion with time during the electrochemical etching process.

25. The method of **claim 1** wherein said semiconductor substrate wafer is of material chosen from the full possible range of alloys and compounds of zinc, cadmium, mercury, carbon, silicon, germanium, tin, lead, aluminum, gallium, indium, bismuth, nitrogen, oxygen, phosphorus, arsenic, antimony, sulfur, selenium and tellurium.

26. The method of **claim 1**, wherein at least one layer of substantially transparent material is deposited onto the pore walls.

27. The method of **claim 26**, wherein each of said at least one layer of substantially transparent material is deposited by a technique selected from the group consisted of chemical vapor deposition, atomic layer deposition, photochemical decomposition and thermal oxidation.
28. The method of **claim 1**, wherein at least one layer of absorptive and/or reflective material is deposited on the pore walls over at least part of the pore depth.
29. The method of **claim 28**, wherein each of said at least one layer of reflective and/or absorptive material is deposited by a technique selected from the group consisting of chemical vapor deposition, atomic layer deposition, photochemical decomposition, electroplating, electroless plating, die casting and molding.
30. The method of **claim 1**, further including the removal of the unetched remainder of the wafer.
31. The method of **claim 30**, wherein said removal of the unwanted remainder of the wafer comprises a step selected from the group consisting of Reactive Ion Etching, chemical etching, grinding, mechanical and/or chemical-mechanical polishing.
32. The method of **claim 31**, wherein the chemically resistant layer is deposited on the pore walls prior to said removal of the unwanted remainder of the wafer.
33. The method of **claim 32**, wherein said chemically-resistant layer comprises Si_3N_4 or silicon dioxide having a thickness from about 5nm to about 500nm and is applied by one of the many variants of chemical vapor deposition or thermal oxidation.
34. The method of **claim 33**, further including removing the chemically resistant layer from the pore walls after the removal of the said unwanted remainder of the wafer.
35. The method of **claim 26**, including the removal of the unetched remainder of the wafer prior to said deposition of said at least one layer of substantially transparent material onto the pore walls.

36. The method of **claim 1**, further including coating the first, second or both surfaces of said spectral filter with at least one layer of material intended to suppress the reflection from said surfaces of said spectral filter in at least some wavelength ranges inside the transparency wavelength range of said spectral filter.

37. The method of **claim 36** wherein said antireflective structure is disposed by the technique chosen from the group consisting of thermal oxidation, chemical vapor deposition, physical vapor deposition and/or thermal evaporation.

38. The method of **claim 1** further including sealing said spectral filter with two flat plates of material that is transparent within the transparency range of said spectral filter.

39. The method of **claim 37** wherein said sealing step comprises at least one of the group consisting of anodic bonding, thermal bonding, glass frit bonding, brazing or adhesive bonding.

40. The method of **claim 1** wherein a roughness suppression procedure is performed subsequently to said etching of the substrate wafer.

41. The method of **claim 40** wherein said roughness suppression procedure includes chemical etching of said pore walls.

42. The method of **claim 41** wherein said chemical etching takes place in a heated alkaline solution.

43. A method of making a spectral filter comprising:
providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,
providing etching start points at a first surface of said semiconductor wafer,
etching the substrate wafer to produce a structured layer having pores with controlled depths defined at least partially therethrough, said pores having coherently modulated cross-sections at least over the part of said depth,
removing at least one un-etched part of the substrate wafer, and
coating the pore walls by at least one layer of substantially transparent material.

44. A method of making a spectral filter comprising:
providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,
etching the substrate wafer to produce a structured layer having pores with
controlled depths defined at least partially therethrough, said pores having coherently
modulated cross-sections at least over the part of said depth,

removing at least one un-etched part of the substrate wafer,
coating the pore walls by at least one layer of substantially transparent material,
and

coating the pore walls at least partially by at least one layer of absorptive or
reflective material.

45. A method of making a spectral filter comprising:

providing a substrate wafer of single-crystal semiconductor having a first
surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,
etching the substrate wafer to produce a structured layer having pores with
controlled depths defined at least partially therethrough, said pores having coherently
modulated cross-sections at least over the part of said depth,

removing at least one un-etched part of the substrate wafer,
coating the pore walls by at least one layer of substantially transparent material,
coating the pore walls at least partially by at least one layer of absorptive or
reflective material, and

sealing said spectral filter with two flat plates of material that is transparent
within the transparency range of said spectral filter.

46. A method of making a spectral filter comprising:

providing a substrate wafer of single-crystal semiconductor having a first
surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,
etching the substrate wafer to produce a structured layer having pores with
controlled depths defined at least partially therethrough, said pores having coherently
modulated cross-sections at least over the part of said depth,

coating the pore walls by at least one layer of substantially transparent material,

coating the pore walls at least partially by at least one layer of absorptive or reflective material,

removing at least one un-etched part of the substrate wafer, and

sealing said spectral filter with two flat plates of material that is transparent within the transparency range of said spectral filter.

47. A method of making a spectral filter comprising:

providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,

etching the substrate wafer to produce a structured layer having pores with controlled depths defined at least partially therethrough, said pores having coherently modulated cross-sections at least over the part of said depth,

coating the pore walls by at least one layer of substantially transparent material,

filling the pores with at least one partially by at least one layer transparent material the refractive index of which is higher than that of the first layer of transparent material coating the pore walls,

removing at least one un-etched part of the substrate wafer, and

sealing said spectral filter with two flat plates of material that is transparent within the transparency range of said spectral filter.

48. A method of making a spectral filter comprising:

providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,

etching the substrate wafer to produce a structured layer having pores with controlled depths defined at least partially therethrough, said pores having coherently modulated cross-sections at least over the part of said depth,

removing at least one un-etched part of the substrate wafer

coating the pore walls by at least one layer of substantially transparent material,

filling the pores with at least one partially by at least one layer transparent material the refractive index of which is higher than that of the first layer of transparent material coating the pore walls, and

sealing said spectral filter with two flat plates of material that is transparent within the transparency range of said spectral filter.

49. A method of making a spectral filter comprising:

providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,

etching the substrate wafer to produce a structured layer having pores with controlled depths defined at least partially therethrough, said pores having coherently modulated cross-sections at least over the part of said depth,

removing at least one un-etched part of the substrate wafer,

thermally oxidizing said structured wafer,

coating the pore walls by at least one layer of substantially transparent material,

filling the pores with at least one partially by at least one layer transparent material the refractive index of which is higher than that of the first layer of transparent material coating the pore walls, and

sealing said spectral filter with two flat plates of material that is transparent within the transparency range of said spectral filter.

50. A method of making a spectral filter comprising:

providing a substrate wafer of single-crystal semiconductor having a first surface and a second surface,

providing etching start points at a first surface of said semiconductor wafer,

etching the substrate wafer to produce a structured layer having pores with controlled depths defined at least partially therethrough, said pores having coherently modulated cross-sections at least over the part of said depth,

removing at least one un-etched part of the substrate wafer,

thermally oxidizing said structured wafer,

coating the pore walls by at least one layer of substantially transparent material, the refractive index of which is lower than that of the semiconductor oxide, and

sealing said spectral filter with two flat plates of material that is transparent within the transparency range of said spectral filter.